



Education and Sport Development

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NORTH WEST PROVINCE

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

SEPTEMBER 2019

MARKS: 150

DURATION: 3 hours

This question paper consists of 14 pages, 4 data sheets and a GRAPH PAPER.

INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on your ANSWER BOOK.
2. This question paper consists of TEN questions. Answer QUESTION 5 2.3 on the attached GRAPH PAPER. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, et cetera where required.
11. You are advised to use the attached DATA SHEETS
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A. D) next to the question numbers (1.1. 1.10) in the ANSWER BOOK, for example 1.11 D.

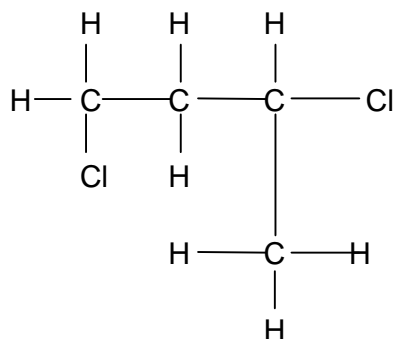
1.1 Which ONE of the following compounds is saturated?

- A $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_3$
- B $\text{CH}_3\text{CH}_2\text{CHCH}_2$
- C $\text{CH}_3\text{CHCHCH}_3$
- D $\text{CH}_3\text{C}(\text{CH}_3)_2\text{CHCH}_2$ (2)

1.2 Which ONE of the following pair of compounds are FUNCTIONAL isomers?

- A Methanol and methanal
- B Butane and 2-methylpropane
- C Propan-1-ol and propan-2-ol
- D Propanoic acid and methyl ethanoate (2)

1.3 The structural formula of an organic compound is shown below:



Which ONE of the following is the correct IUPAC name of this compound?

- A 2,4-dichloro-2-methylpropane
- B 1,3-dichloro-3-methylpropane
- C 1,3-dichlorobutane
- D 2,4-dichlorobutane (2)

- 1.4 Which ONE of the following is the EMPIRICAL FORMULA of 1,2-dichloroethane?
- A CHC
 - B CH₂C
 - C CHC₂
 - D C₂H₄C₂ (2)
- 1.5 In which ONE of the solutions will the metallic ion be displaced by lead (Pb)? Use the Table of Standard Reduction Potentials to determine your answer.
- A Magnesium nitrate
 - B Zinc nitrate
 - C Silver nitrate
 - D Potassium nitrate (2)
- 1.6 In a chemical reaction, the difference between the potential energy of the products and the potential energy of the reactants is equal to the ...
- A change in enthalpy of the reaction.
 - B rate of the reaction.
 - C activation energy of the reaction.
 - D total potential energy of the particles. (2)
- 1.7 The solution that will have the LOWEST concentration of H⁺ ions if complete ionisation takes place, is ...
- A 0,4 dm³ of a 1 mol dm⁻³ H₂SO₄ solution.
 - B 0,4 dm³ of a 1 mol dm⁻³ HC solution.
 - C 0,4 dm³ of a 1 mol dm⁻³ CH₃COOH solution.
 - D 1 dm³ of a 1 mol dm⁻³ HC solution. (2)

- 1.8 Consider the following equilibrium constants for the same reaction at two different temperatures:

$$298 \text{ K} : K_c = 0,03$$

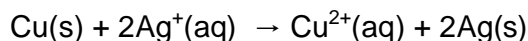
$$318 \text{ K} : K_c = 0,005$$

Which ONE of the following is CORRECT?

	HEAT OF REACTION	YIELD OF PRODUCTS AS THE TEMPERATURE INCREASES
A	^a $H > 0$	Increases
B	^a $H < 0$	Decreases
C	^a $H > 0$	Decreases
D	^a $H < 0$	Remains the same

(2)

- 1.9 Consider the reaction represented by the balanced equation below:



In the above reaction, Cu(s) is the

- A oxidizing agent and is reduced.
- B oxidizing agent and is oxidised.
- C reducing agent and is reduced.
- D reducing agent and is oxidised.

(2)

- 1.10 The NPK ratio for a 20 kg bag of fertilizer is 4:3:2(40). The percentage phosphorous in the bag is:

- A 8,89%
- B 13,33%
- C 17,78%
- D 6,67%

(2)
[20]

QUESTION 2 (Start on a new page.)

- 2.1 Define the term *functional group* of organic compounds. (2)
- 2.2 The IUPAC name of an organic compound is 3,4-dimethylpentan-2-one. For this compound, write down the:
- 2.2.1 Homologous series to which it belongs (1)
- 2.2.2 Structural formula (3)
- 2.3 Study the organic compounds represented by the letters **A** to **C** below:

A	$\text{CH}_3\text{COCH}_2\text{CH}_3$	
B	<pre> H H C Br H H - C - C - C - C - C - H H H H H C H </pre>	C
		<pre> H H H H - C - C - C ≡ C - C - H H H C H </pre>

Write down the:

- 2.3.1 General formula for compound **C** (1)
- 2.3.2 Structural formula of the compound that is a functional isomer of compound **A** (2)
- 2.3.3 IUPAC name of compound **B** (3)

[12]

QUESTION 3 (Start on a new page.)

The vapour pressures of straight-chain alkanes and straight-chain alcohols, together with their molecular masses, are given in the table below.
(Compounds **A**, **B**, **C** and **D**)

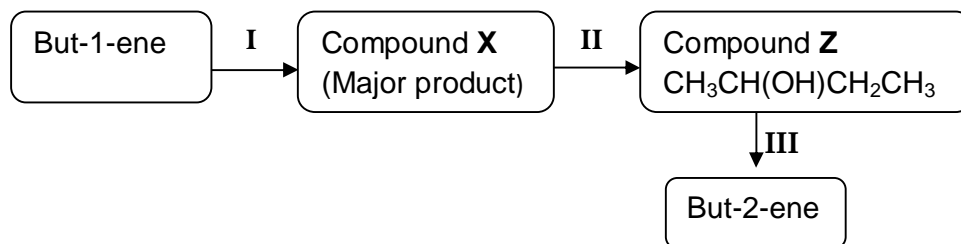
	COMPOUNDS	VAPOUR PRESSURE (kPa)	MOLECULAR MASS (g·mol ⁻¹)
A	Propane	853,16	44
B	Butane	112	58
C	Propan-1-ol	2,4	60
D	Butan-1-ol	0,1	74

- 3.1 The vapour pressures of compound **C** and **D** are compared. Write down the:
- 3.1.1 Independent variable (1)
- 3.1.2 Dependent variable (1)
- 3.2 Explain the difference between the vapour pressure of the alkane and the alcohol, each having FOUR carbon atoms per molecule, by referring to the TYPE of intermolecular forces in each compound. (4)
- 3.3 Compound **B** has an isomer.
- 3.3.1 Write down the structural formula of this isomer. (2)
- 3.3.2 Give the IUPAC name of the isomer in QUESTION 3.3.1. (2)
- 3.3.3 State what type of isomer this is. Choose from CHAIN, POSITIONAL or FUNCTIONAL isomer. (1)
- 3.4 Which ONE of compounds **A** to **D** has the highest boiling point? Explain your answer. (2)

[13]

QUESTION 4 (Start on a new page.)

The flow diagram below shows the steps that a learner follows to convert but-1-ene to but-2-ene. I, II and III represent different types of reactions.



4.1 Compound **X** is formed when but-1-ene reacts with HC (g) .

Write down:

4.1.1 TWO reaction conditions for this reaction (2)

4.1.2 The IUPAC name of compound **X** (2)

4.2 Name the type of reactions represented by

4.2.1 **I** (1)

4.2.2 **II** (1)

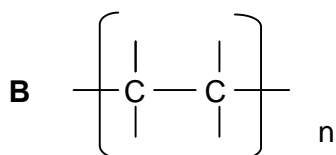
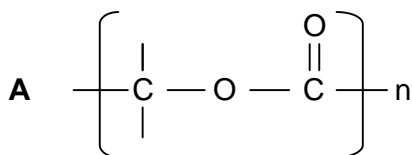
4.2.3 **III** (1)

4.3 Compound **Z** is converted to but-2-ene in the presence of concentrated sulphuric acid, in a warm water bath.

4.3.1 Is compound **Z** a PRIMARY, SECONDARY or TERTIARY alcohol?
Explain your answer. (3)

4.3.2 Why is compound **Z** heated in a water bath? (1)

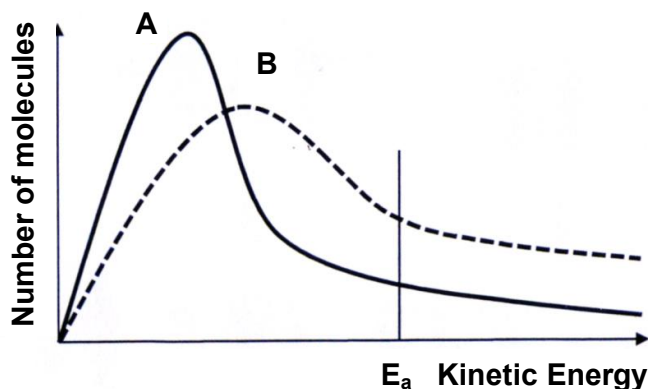
4.4 Polymerisation can occur by an addition or condensation reaction.
The repeating units of two polymers, **A** and **B**, are shown below.



- 4.4.1 Explain what a condensation polymer is. (2)
- 4.4.2 Which unit, **A** or **B**, is a condensation polymer? (1)
- 4.4.3 Give the molecular formula of the monomer for polymer **B**. (1)
- [15]**

QUESTION 5 (Start on a new page.)

- 5.1 Below is the Maxwell-Boltzmann distribution curves of the kinetic energy of molecules at two different temperatures.



- 5.1.1 What do the areas beneath both graphs **A** and **B** and to the right of E_a , represent? (1)
- 5.1.2 Which ONE of the graphs, **A** or **B**, represents the reaction taking place at the higher temperature? (1)
- 5.2 A group of learners use the reaction between excess hydrochloric acid with magnesium to investigate one of the factors that influences the rate of a chemical reaction. The balanced equation for this reaction is given below:



Two experiments are conducted. In **Experiment 1**, 5 g of magnesium ribbon is used, and in **Experiment 2**, 5 g magnesium powder is used. The volume of hydrogen gas produced in each experiment is measured. The results obtained are shown in the tables below:

EXPERIMENT 1: Using Mg ribbon

TIME (minutes)	0	0,5	1,0	1,5	2,0	2,5	3,0	3,5	4,0
Volume of H₂ collected in cm³	0	15	25	30	33	35	35	35	35

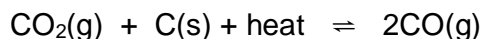
EXPERIMENT 2: Using Mg powder

TIME (minutes)	0	0,5	1,0	1,5	2,0	2,5	3,0	3,5	4,0
Volume of H₂ collected in cm³	0	23	30	33	35	35	35	35	35

- 5.2.1 For this investigation, write down the:
- (a) Investigative question (2)
 - (b) Controlled variables (2)
- 5.2.2 Refer to the table for experiment **1**. Explain why the volume of H₂ collected remains constant after 2,5 minutes. (1)
- 5.2.3 Plot TWO line-graphs for the volume of H₂ collected versus time for Experiments **1** and **2** for both on the same set of axes. Clearly label your graphs **1** and **2**. (4)
- 5.2.4 Which ONE of the experiments, **1** or **2**, occurred at a higher rate? (1)
- 5.2.5 Explain your answer to QUESTION 5.2.4 in terms of the collision theory. (3)
- 5.2.6 Determine the average rate of formation of H₂ gas in Experiment **1** for t = 0 min to t = 0,5 minutes. (3)
- [18]**

QUESTION 6 (Start on a new page.)

Carbon dioxide reacts with carbon in a closed system to produce carbon monoxide (CO), according to the following balanced equation:



- 6.1 Explain the term *closed system*. (2)
- 6.2 Is the above reaction an EXOTHERMIC or ENDOTHERMIC? Give a reason for the answer. (2)

Initially an unknown amount of carbon dioxide is exposed to hot carbon at 800 °C in a sealed 2 dm³ container. The equilibrium constant, K_c, for the reaction is 14. At equilibrium it is found that 168 g carbon monoxide is present.

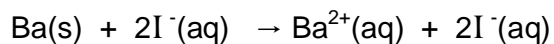
- 6.3 How will the equilibrium concentration of the product compare to that of the reactants? Choose from: LARGER THAN, SMALLER THAN or EQUAL TO. Give a reason for your answer. (No calculation is required.) (2)
- 6.4 Calculate the initial amount (in moles) of CO₂(g) present. (9)
- 6.5 If more carbon is added at a constant temperature, how will this affect the yield of CO(g) at equilibrium? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)
- [16]**

QUESTION 7 (Start on a new page.)

- 7.1 A monoprotic acid HY ionises completely when dissolved in water. The hydroxide ion concentration $[\text{OH}^-]$ in the solution is $1 \times 10^{-11} \text{ mol}\cdot\text{dm}^{-3}$.
- 7.1.1 Define an acid in terms of the Brønsted-Lowry theory. (2)
- 7.1.2 Define the term *monoprotic acid*. (2)
- 7.1.3 Is acid HY a WEAK or a STRONG acid? Give a reason for your answer. (2)
- 7.1.4 Calculate the following:
- (a) The concentration of hydronium ions $[\text{H}_3\text{O}^+]$ in the solution. (3)
- (b) The pH of the solution (3)
- 7.2 A sample of sodium carbonate (Na_2CO_3) is dissolved in water.
- Write down:
- 7.2.1 Equation for the hydrolysis of the carbonate ion (CO_3^{2-}) in water (3)
- 7.2.2 Formula of the conjugate acid of the carbonate ion (CO_3^{2-}) (1)
- 4,24 g of sodium carbonate (Na_2CO_3) is dissolved in water. The solution is neutralised by 250 cm^3 of a hydrochloric acid (HC) solution according to the following balanced equation:
- $$\text{Na}_2\text{CO}_3(\text{s}) + 2\text{HC}(\text{aq}) \rightarrow 2\text{NaC}(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{ l })$$
- 7.2.3 Calculate the concentration of the HC solution. (6)
- [22]**

QUESTION 8 (Start on a new page.)

A standard electrochemical cell is set up. The overall (net) balanced equation is shown below.



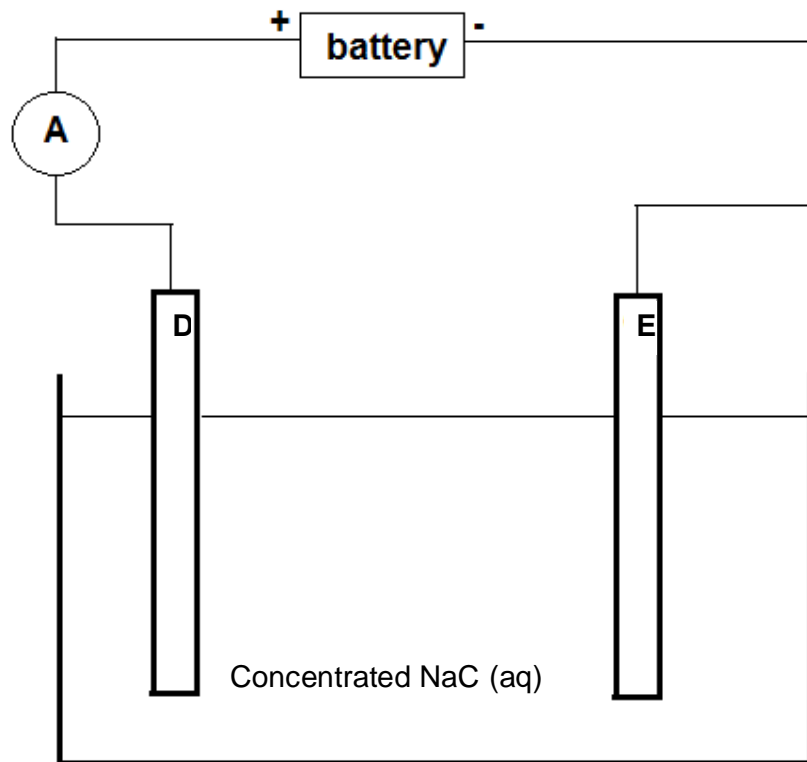
When this cell is in operation under standard conditions, chemical energy is converted into electrical energy.

- 8.1 What type of electrochemical cell is this? (1)
- 8.2 Write down the:
- 8.2.1 Oxidation half-reaction that takes place in this cell (2)
- 8.2.2 Direction in which electrons will flow? Choose from IODINE TO BARIUM half-cell or BARIUM TO IODINE half-cell (1)
- 8.2.3 Cell notation for this cell (3)
- 8.3 Calculate the emf of the cell. (4)
- 8.4 Is the cell reaction spontaneous or a non-spontaneous? Give a reason for your answer. (2)
- 8.5 How will the voltmeter reading in QUESTION 8.3 be affected if the concentration of barium ions $[\text{Ba}^{2+}(\text{aq})]$ is increased? Choose from: INCREASE, DECREASE or REMAINS THE SAME. (1)

[14]

QUESTION 9 (Start on a new page.)

In the simplified sketch below, carbon electrodes are used during the electrolysis of a concentrated sodium chloride solution.



- 9.1 Define the term *electrolysis*. (2)
- 9.2 Write down the:
- 9.2.1 Half-reaction that takes place at electrode **E** (2)
- 9.2.2 NAME or FORMULA of the gas released at electrode **D** (1)
- 9.2.3 Balanced equation for the net (overall) cell reaction (3)
- [8]**

QUESTION 10 (Start on a new page.)

Ammonia is an important fertiliser and is produced on a large scale in the industry.

10.1 For the industrial preparation of ammonia, write down the:

10.1.1 NAME of the process during which ammonia is prepared (1)

10.1.2 NAME of the catalyst used in this process (1)

10.1.3 A balanced chemical equation for this process (3)

10.1.4 FORMULAE of two fertilisers prepared from ammonia (2)

10.2 A farmer grows spinach on his farm and wants to use a fertiliser which promotes green leaves. He needs to choose from the following available fertilisers:

Potassium chloride, calcium hydrogen phosphate and ammonium nitrate.

10.2.1 Which ONE of the above fertilisers will be the best choice? Give a reason for your answer. (2)

10.2.2 Calculate the percentage mass of NITROGEN in ammonium nitrate. (3)

[12]

TOTAL: 150

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)**

**GEGEWENS VIR FISIESTE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESTE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Standard pressure <i>Standaarddruk</i>	p^θ	$1,013 \times 10^5 \text{ Pa}$
Molar gas volume at STP <i>Molêre gasvolume by STD</i>	V_m	$22,4 \text{ dm}^3 \text{ mol}^{-1}$
Standard temperature <i>Standaardtemperatuur</i>	T^θ	273 K
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Avogadro's constant <i>Avogadro-konstante</i>	N_A	$6,02 \times 10^{23} \text{ mol}^{-1}$

TABLE 2: FORMULAE/TABEL 2: FORMULES

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$\text{pH} = -\log[\text{H}_3\text{O}^+]$
$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14}$ at/by 298 K	
$E_{\text{cell}} = E_{\text{cathode}} - E_{\text{anode}} / E_{\text{sel}} = E_{\text{katode}} - E_{\text{anode}}$	
or/of	
$E_{\text{cell}} = E_{\text{reduction}} - E_{\text{oxidation}} / E_{\text{sel}} = E_{\text{reduksie}} - E_{\text{oksidasie}}$	
or/of	
$E_{\text{cell}} = E_{\text{oxidising agent}} - E_{\text{reducing agent}} / E_{\text{sel}} = E_{\text{oksideermiddel}} - E_{\text{reduseermiddel}}$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS/TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)	
2,1 1 H 1																	2 He 4	
1,0 3 Li 7	1,5 4 Be 9											2,0 5 B 11	2,5 6 C 12	3,0 7 N 14	3,5 8 O 16	4,0 9 F 19	10 Ne 20	
0,9 11 Na 23	1,2 12 Mg 24											1,5 13 Al 27	1,8 14 Si 28	2,1 15 P 31	2,5 16 S 32	3,0 17 Cl 35,5	18 Ar 40	
0,8 19 K 39	1,0 20 Ca 40	1,3 21 Sc 45	1,5 22 Ti 48	1,6 23 V 51	1,6 24 Cr 52	1,5 25 Mn 55	1,8 26 Fe 56	1,8 27 Co 59	1,8 28 Ni 59	1,9 29 Cu 63,5	1,6 30 Zn 65	1,6 31 Ga 70	1,8 32 Ge 73	2,0 33 As 75	2,4 34 Se 79	2,8 35 Br 80	36 Kr 84	
0,8 37 Rb 86	1,0 38 Sr 88	1,2 39 Y 89	1,4 40 Zr 91	1,6 41 Nb 92	1,8 42 Mo 96	1,9 43 Tc 98	2,2 44 Ru 101	2,2 45 Rh 103	2,2 46 Pd 106	1,9 47 Ag 108	1,7 48 Cd 112	1,7 49 In 115	1,8 50 Sn 119	1,9 51 Sb 122	2,1 52 Te 128	2,5 53 I 127	54 Xe 131	
0,7 55 Cs 133	0,9 56 Ba 137	1,6 57 La 139	1,6 72 Hf 179	1,8 73 Ta 181	1,8 74 W 184	1,9 75 Re 186	2,2 76 Os 190	2,2 77 Ir 192	2,2 78 Pt 195	1,9 79 Au 197	1,7 80 Hg 201	1,8 81 Tl 204	1,8 82 Pb 207	1,9 83 Bi 209	2,0 84 Po	2,5 85 At	86 Rn	
0,7 87 Fr	0,9 88 Ra 226	89 Ac																
			58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175		
			90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr		

KEY/SLEUTEL

Atomic number
Atoomgetal

Electronegativity
Elektronegatiwiteit

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

Diagram illustrating the periodic table with a callout box for Copper (Cu). The callout box shows the atomic number (29) at the top, the symbol (Cu) in the center, and the approximate relative atomic mass (63,5) at the bottom. Arrows point from the callout box to the corresponding cell in the periodic table.

TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Half-reactions/ <i>Halfreaksies</i>	(V)
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$C_2(g) + 2e^- \rightleftharpoons 2C^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(l)$	+ 0,85
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	0,00
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	- 0,06
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	- 0,13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	- 0,14
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	- 0,27
$Co^{2+} + 2e^- \rightleftharpoons Co$	- 0,28
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	- 0,40
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	- 0,41
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	- 0,44
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	- 0,74
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	- 0,76
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	- 0,83
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	- 0,91
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	- 1,18
$Al^{3+} + 3e^- \rightleftharpoons Al$	- 1,66
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	- 2,36
$Na^+ + e^- \rightleftharpoons Na$	- 2,71
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	- 2,87
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	- 2,89
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	- 2,90
$Cs^+ + e^- \rightleftharpoons Cs$	- 2,92
$K^+ + e^- \rightleftharpoons K$	- 2,93
$Li^+ + e^- \rightleftharpoons Li$	- 3,05

Increasing oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reduserende vermoë

TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

Increasing oxidising ability/Toenemende oksiderende vermoë

Half-reactions/Halfreaksies	E ⁰ (V)
$\text{Li}^+ + \text{e}^- \rightleftharpoons \text{Li}$	- 3,05
$\text{K}^+ + \text{e}^- \rightleftharpoons \text{K}$	- 2,93
$\text{Cs}^+ + \text{e}^- \rightleftharpoons \text{Cs}$	- 2,92
$\text{Ba}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ba}$	- 2,90
$\text{Sr}^{2+} + 2\text{e}^- \rightleftharpoons \text{Sr}$	- 2,89
$\text{Ca}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ca}$	- 2,87
$\text{Na}^+ + \text{e}^- \rightleftharpoons \text{Na}$	- 2,71
$\text{Mg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mg}$	- 2,36
$\text{Al}^{3+} + 3\text{e}^- \rightleftharpoons \text{Al}$	- 1,66
$\text{Mn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mn}$	- 1,18
$\text{Cr}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cr}$	- 0,91
$2\text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^-$	- 0,83
$\text{Zn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Zn}$	- 0,76
$\text{Cr}^{3+} + 3\text{e}^- \rightleftharpoons \text{Cr}$	- 0,74
$\text{Fe}^{2+} + 2\text{e}^- \rightleftharpoons \text{Fe}$	- 0,44
$\text{Cr}^{3+} + \text{e}^- \rightleftharpoons \text{Cr}^{2+}$	- 0,41
$\text{Cd}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cd}$	- 0,40
$\text{Co}^{2+} + 2\text{e}^- \rightleftharpoons \text{Co}$	- 0,28
$\text{Ni}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ni}$	- 0,27
$\text{Sn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Sn}$	- 0,14
$\text{Pb}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pb}$	- 0,13
$\text{Fe}^{3+} + 3\text{e}^- \rightleftharpoons \text{Fe}$	- 0,06
$2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{S}(\text{g})$	+ 0,14
$\text{Sn}^{4+} + 2\text{e}^- \rightleftharpoons \text{Sn}^{2+}$	+ 0,15
$\text{Cu}^{2+} + \text{e}^- \rightleftharpoons \text{Cu}^+$	+ 0,16
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+ 0,17
$\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$	+ 0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^- \rightleftharpoons 4\text{OH}^-$	+ 0,40
$\text{SO}_2 + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{S} + 2\text{H}_2\text{O}$	+ 0,45
$\text{Cu}^+ + \text{e}^- \rightleftharpoons \text{Cu}$	+ 0,52
$\text{I}_2 + 2\text{e}^- \rightleftharpoons 2\text{I}^-$	+ 0,54
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{O}_2$	+ 0,68
$\text{Fe}^{3+} + \text{e}^- \rightleftharpoons \text{Fe}^{2+}$	+ 0,77
$\text{NO}_3^- + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+ 0,80
$\text{Ag}^+ + \text{e}^- \rightleftharpoons \text{Ag}$	+ 0,80
$\text{Hg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Hg}(\text{g})$	+ 0,85
$\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^- \rightleftharpoons \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+ 0,96
$\text{Br}_2(\text{l}) + 2\text{e}^- \rightleftharpoons 2\text{Br}^-$	+ 1,07
$\text{Pt}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pt}$	+ 1,20
$\text{MnO}_2 + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+ 1,23
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+ 1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+ 1,33
$\text{C}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{C}^-$	+ 1,36
$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+ 1,51
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+ 1,77
$\text{Co}^{3+} + \text{e}^- \rightleftharpoons \text{Co}^{2+}$	+ 1,81
$\text{F}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{F}^-$	+ 2,87

Increasing reducing ability/Toenemende reduserende vermoë

